

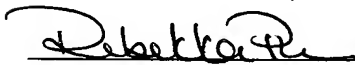
Docket No.: 2003P18854

CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of PCT/EP2005/050113, filed with the European Patent Office on January 12, 2005.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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July 17, 2006

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1 Description

2

3 Circuit configuration for recognizing the occupancy of a seat
4 and seatbelt warning in a motor vehicle

5

6 The invention relates to a circuit configuration for
7 recognizing the occupancy of a seat and seatbelt warning in a
8 motor vehicle. Resistance elements are arranged in a
9 separated and flat manner on a motor vehicle seat which
10 alters the resistance values when for example a normal force
11 is exerted perpendicular to the surface of the vehicle seat,
12 and/or by bending. The resistance elements, which can be said
13 to be sensitive both to weight and to bending, comprise not
14 only first resistance elements for recognizing the occupancy
15 of a seat, being connected to one another in parallel within
16 a first measuring circuit between a first measuring
17 connection and a second measuring connection, but also
18 additional resistance elements for providing a seatbelt
19 warning. The additional resistance elements are used to
20 recognize whether there is a person or an object on a vehicle
21 seat and to give a warning if in addition the person
22 recognized does not fasten the seat belt.

23

24 The use of weight-sensitive resistance elements for the
25 purpose of recognizing seat occupancy in motor vehicles is
26 sufficiently well known from automotive engineering. For
27 example, with the aid of a vehicle seat having on its surface
28 sensor seating mats consisting of resistance elements which
29 are sensitive to weight (and to bending in the sense
30 mentioned above), any change in the resistance values of the
31 resistance elements due to normal force (and/or bending) is
32 used as seat occupancy information. If necessary the said
33 information is used to make some form of passenger restraint

1 ready for triggering, for instance by arming or disabling a
2 front or side airbag.

3
4 Such arrangements of resistors as sensor seating mats are
5 known from the German utility model DE 200 14 200 U1 and from
6 the article "Occupant Classification System for Smart
7 Restraint System", Society of Automotive Engineers Inc.,
8 1999, BNSDOCID XP-002184965. Examples of weight-sensitive
9 resistance elements that are suitable as sensor elements in
10 sensor seating mats are known from European patent document 0
11 758 741 B1.

12
13 In a further known arrangement, in parallel with the variable
14 resistance elements used hitherto in a sensor seating mat for
15 recognizing seat occupancy, two further resistance elements,
16 possibly constructed in the same way as the other resistance
17 elements, are coupled in series and so arranged that it is
18 possible to distinguish reliably between a heavy object and a
19 vehicle occupant. For example it can be helpful to fix each
20 of the two further resistance elements to a location on the
21 surface of the vehicle seat usually occupied by the hip bones
22 of a vehicle occupant. In this case, the resistance value of
23 the two further weight-sensitive resistance elements falls.
24 Once a person has been recognized in this way, a warning
25 message is given to the passenger or at least to the driver
26 if the seat belt associated with the vehicle seat occupied by
27 a recognized person is not done up at the time of
28 recognition. An appropriate seatbelt warning can be an
29 audible signal or an appropriate warning lamp on the vehicle
30 instrument panel.

31
32 Lower resistance values in the resistance elements for
33 seatbelt warning are differentiated from a change in the

1 resistance values of the resistance elements for recognizing
2 seat occupancy by the fact that the two types of resistance
3 element have different resistance value ranges.

4
5 The disclosed arrangement therefore has the disadvantage that
6 the two additional resistance elements for providing a
7 seatbelt warning and the other resistance elements for
8 recognizing seat occupancy have to be constructed differently
9 in order to have different measurement ranges. In some cases
10 this may involve additional labor costs during manufacture.

11
12 Moreover the known system is also intended to recognize when
13 there is a break in a power supply line to one of the seating
14 mat resistance elements. This is achieved in that a
15 diagnostic resistor or diagnostic diode is connected in
16 parallel to the weight-sensitive resistance elements of the
17 sensor seating mat. In fact the results of measuring the
18 resistance value of the diagnostic diode or the diagnostic
19 resistor are strongly influenced by the weight-sensitive
20 resistance elements for seatbelt warning and the resistance
21 elements for recognizing seat occupancy. Therefore the
22 measurement ranges of the diagnostic resistor or the
23 diagnostic diode also have to be different from the
24 measurement ranges of the weight-sensitive resistance
25 elements.

26
27 The object of the present arrangement, in the case of a
28 sensor seating mat equipped with resistance elements for
29 recognizing seat occupancy, is on the one hand to be able to
30 measure the resistance on the seatbelt warning resistance
31 elements independently of the corresponding measurement on
32 the resistance elements for recognizing seat occupancy, and
33 on the other to be able recognize when there is a break in

1 the power supply lines in a way that is not simultaneously
2 affected by the seatbelt warning resistance elements and the
3 resistance elements for recognizing seat occupancy.

4
5 This object is achieved by means of a circuit configuration
6 having the features which will emerge from Claim 1.

7
8 According to the invention, the circuit configuration for
9 recognizing the occupancy of a seat and seatbelt warning in a
10 motor vehicle has first resistance elements which are not
11 only weight-sensitive but also usually sensitive to bending
12 and used for recognizing seat occupancy in a vehicle occupant
13 protection system, as well as additional resistance elements
14 which provide signals that may cause a vehicle occupant to be
15 warned that a seat belt has been left undone. The first
16 resistance elements are connected to one another in parallel
17 within a first measuring circuit between a first measuring
18 connection and a second measuring connection. According to
19 the invention, a first additional resistance element is
20 connected in a second measuring circuit between the first
21 measuring connection and a third measuring connection, and a
22 second additional resistance element is connected in a third
23 measuring circuit between the second measuring connection and
24 a fourth measuring connection. By this means, when measuring
25 the resistance on the first additional resistance element via
26 the first and third measuring connections of the circuit
27 configuration and when measuring the resistance on the second
28 additional resistance element via the second and fourth
29 measuring connections of said arrangement, the first
30 resistance elements of the sensor seating mat are
31 electrically bypassed in each case, so that at the moment of
32 measuring, a force being instantaneously exerted on the first
33 resistance elements cannot corrupt the respective measurement

1 results for the additional resistance elements.

2
3 Further exemplary embodiments of a circuit configuration
4 according to the invention are specified in the individual
5 subclaims.

6
7 For example it is advantageous if all resistance elements,
8 that is, the first resistance elements and the additional
9 resistance elements, are arranged as sensor elements on a
10 seating mat for sensing the seat occupancy in a motor
11 vehicle. At the same time it is particularly advantageous if
12 the first resistance elements and the additional resistance
13 elements have the same structural form, since they can then
14 be very easily manufactured within the same production
15 processes.

16
17 Furthermore it is advantageous to arrange a first diagnostic
18 resistor parallel to the first additional resistance element
19 and if necessary also a second diagnostic resistor parallel
20 to the second additional resistance element. Due to the fact
21 that the second measuring circuit and the third measuring
22 circuit electrically bypass the first resistance elements,
23 the variable resistance values of the first resistance
24 elements have no effect at all on measurement of the two
25 diagnostic resistors. It is therefore merely necessary to
26 make sure that during manufacture the measurement range of
27 the parallel additional resistance elements for seatbelt
28 warning is made wide enough to be distinguishable from the
29 resistance values of the two diagnostic resistors.

30
31 Alternatively a diagnostic resistor can also be arranged
32 parallel to the first resistance elements of the sensor
33 seating mat for recognizing seat occupancy in such a way that

1 its resistance value has no effect on the two additional
2 resistance elements for seatbelt warning and is just wide
3 enough to be distinguishable from the value range of the
4 total resistance of the parallel first resistance elements.

5
6 Moreover it is advantageous to manufacture the resistance
7 elements for recognizing seat occupancy in "through mode"
8 technology.

9
10 A sensor seating mat usually consists of a first and a second
11 backing film kept apart from one another by spacers. At the
12 locations of the sensor elements, a first conducting
13 structure is attached to the first backing film and a second
14 conducting structure to the second backing film so that they
15 are opposite one another, both conducting structures having
16 first and second electrical connections in each case. When a
17 normal force or a bending force is exerted on the backing
18 films the two conducting structures move closer together and
19 eventually make contact, forming a contact surface with
20 contact resistance which varies in proportion to the size of
21 the normal force or the size and nature of the bending force.
22 Through mode technology denotes that a weight-dependent
23 resistance element, being a sensor element, is formed via the
24 conducting section from the first electrical connection of
25 the first conducting structure, via the contact surface of
26 both conducting structures that becomes conducting when
27 subjected to a weight loading, through to the second
28 connection of the second conducting structure. Through mode
29 technology makes it possible to arrange power supply lines to
30 the weight-dependent resistance elements on one of the
31 backing films and return lines from the resistance elements
32 on the opposite backing film. In comparison with other
33 technologies therefore, through mode technology allows the

1 developer much greater freedom to arrange resistance elements
2 on a sensor seating mat without being forced by space
3 limitations to fit the sensor seating mat with supply lines
4 that are too close together or even crossing, which could
5 reduce the mechanical durability of the sensor seating mat
6 and would make the signals from the resistance elements more
7 susceptible to electromagnetic interference.

8
9 Since the two resistance elements for seatbelt warning are
10 usually positioned near the edges of the sensor seating mat,
11 and as described above are usually at the supporting points
12 for the hip bones of a vehicle occupant, they are few in
13 number and their power supply lines are mostly quite short,
14 so that the seatbelt warning resistance elements may also be
15 constructed in the more conventional "shunt mode" technology:
16 a weight-dependent resistance element, being a sensor
17 element, is then formed for instance via the conducting
18 section from a first electrical connection of a first
19 conducting structure of the resistance element on the first
20 backing film, via a contact surface on the second backing
21 film that is conducting when subjected to a weight loading,
22 through to a second connection of a second conducting
23 structure of the resistance element, though said second
24 structure is arranged on the first backing film. Thus when
25 the contact surface on the second backing film is subjected
26 to pressure and/or bending, it merely provides the resistance
27 element with a bypass resistance, that is, a shunt
28 resistance.

29
30 The invention will be described below with the aid of an
31 exemplary embodiment and a plurality of figures. The figures
32 show the following:

33

1 Figure 1 A circuit configuration according to the invention,

2

3 Figure 2 A known circuit configuration,

4

5 Figure 3 A vehicle seat 2 with a sensor seating mat PPD
6 having first resistance elements (R1, R2, R3,...) and
7 additional weight-dependent resistance elements R_SBR_1,
8 R_SBR_2,

9

10 Figure 4 A resistance element R1 for recognizing seat
11 occupancy in through mode technology,

12

13 Figure 5 The resistance element R1 for recognizing seat
14 occupancy according to Figure 4 in cross-section,

15

16 Figure 6 A resistance element R_SBR_1 for recognizing seat
17 occupancy in shunt mode technology and

18

19 Figure 7 The resistance element R_SBR_1 for recognizing seat
20 occupancy according to Figure 6 in cross-section.

21

22 Figure 3 shows a vehicle seat 3, on the surface of which a
23 sensor seating mat PPD is arranged. The sensor seating mat
24 has first resistance elements R1, R2, R3,... with weight-
25 dependent variable resistance values which act as sensor
26 elements 1 for recognizing seat occupancy in a motor vehicle.
27 The sensor seating mat PPD also has two additional resistance
28 values R_SBR_1 and R_SBR_2 with likewise weight-dependent
29 variable resistance values. These two additional resistance
30 elements R_SBR_1 and R_SBR_2 are arranged at locations on the
31 vehicle seat 2 usually occupied by the hip bones of a vehicle
32 occupant. This means that a strong force is exerted on these
33 two additional resistance elements R_SBR_1 and R_SBR_2 by a

1 person occupying the vehicle seat, whereas an object does not
2 usually cause this particular loading. A control unit in the
3 motor vehicle makes use of this distinction between a person
4 and an object to issue a warning if a vehicle seat is
5 occupied by a person and the person detected in said seat has
6 not fastened the seat belt.

7
8 Figure 2 shows two first and two additional resistance
9 elements R1, R2, R_SBR_1, R_SBR_2 of the sensor seating mat
10 PPD from Figure 3 in a known circuit configuration. The two
11 first resistance elements R1 and R2 shown are merely
12 exemplary of a plurality of first resistance elements of a
13 sensor seating mat PPD, as is made clear by the interrupted
14 lines connecting to the first and second electrical
15 connections 3, 4 of the two resistance elements R1, R2.

16
17 The two resistance elements R1, R2 together with their
18 respective first electrical connection 3 are connected via a
19 fixed resistor R_F_1 to a first measuring connection C1, and
20 together with their respective second connections 4 are
21 connected via a second fixed resistor R_F_2 to a second
22 measuring connection C2. Furthermore the two additional
23 resistance elements R_SBR_1 and R_SBR_2 are connected in
24 series between the said two measuring connections C1 and C4.

25
26 A resistance is measured via the two measuring connections C1
27 and C2 with the aid of a measuring circuit (not shown), said
28 resistance being largely defined by the first resistance
29 elements R1 and R2 and the two additional resistance elements
30 R_SBR_1 and R_SBR_2.

31
32 In the unoccupied state the first resistance elements R1 and
33 R2 have a resistance value in the M Ω range. As soon as a

1 sufficiently large weight is exerted on the sensor elements
2 R1 and R2, their resistance value is between 40 and 60 k Ω per
3 sensor element R1, R2. In the case of Figure 2 the total
4 resistance value of the two sensor elements R1 and R2 is
5 approx. 25 k Ω . When the two additional resistance elements
6 R_SBR_1 and R_SBR_2 are in the depressed state they have a
7 common resistance value between 0.5 k Ω and 1.5 k Ω . If a
8 person occupies the vehicle seat, then not only the first
9 resistance elements R1, R2 but also the additional resistance
10 elements R_SBR_1 and R_SBR_2 receive a loading. The total
11 resistance of this arrangement of resistors is measurable via
12 the two measuring connections C1 and C2, and in this way is
13 reliably differentiated from a situation in which for example
14 only the first resistance elements R1, R2 receive a weight
15 loading. This makes it possible to determine whether a person
16 is occupying the vehicle seat.

17
18 In order to ensure that the total resistance between C1 and
19 C2 cannot drop below a minimum resistance value when the
20 additional resistance elements R_SBR_1 and R_SBR_2 are under
21 only a light load or no load at all, in the power supply line
22 a first fixed resistor R_F_1 is arranged between the first
23 measuring connection C1 and the first connections 3 of the
24 first resistance elements R1 and R2 and a second fixed
25 resistor R_F_2 is arranged between the second measuring
26 connection C2 and the second electrical connection 4 of the
27 first resistance elements R1 and R2. Said resistors have a
28 fixed resistance value of approx. 20 k Ω each.

29
30 When the additional resistance elements R_SBR_1 and R_SBR_2
31 are under no load, if a break occurs in the line between the
32 first measuring connection C1 and the first resistance
33 elements R1 and R2, or in some cases also between the second

1 measuring connection C2 and the two first resistance elements
2 R1 and R2, a resistance value of several M Ω or greater can be
3 measured between the first measuring connection C1 and the
4 fourth measuring connection C4. In order to distinguish a
5 line interruption unambiguously from a no-load sensor mat,
6 either a diagnostic resistor R_D or a diagnostic diode D_D is
7 connected in parallel with the first resistance elements R1
8 and R2. A diagnostic resistor R_D and a diagnostic diode D_D
9 may be used as alternatives. This is made clear in Figure 2
10 by the broken lines indicating the diagnostic diode D_D
11 between the two measuring connections C1 and C4.

12
13 Figure 1 shows an exemplary embodiment of an inventive
14 circuit configuration. The figure shows three first
15 resistance elements R1, R2 and R3, connected in parallel,
16 which are connected not only to their respective first
17 connections 3 and to the first measuring connection C1 but
18 also to a third measuring connection C3 via a first
19 diagnostic resistor R_D_1 and a first fixed resistor R_F_1
20 connected in series downstream. At their respective second
21 connections 4 the first resistance elements R1, R2 and R3,
22 connected in parallel, are connected both to the second
23 measuring connection C2 and also to the fourth measuring
24 connection C4 via a second diagnostic resistor R_D_2 and a
25 second fixed resistor R_F_2 connected in series downstream. A
26 first additional resistance element R_SBR_1 is connected in
27 parallel to the first diagnostic resistor R_D_1 and a second
28 additional resistance element R_SBR_2 is connected in
29 parallel to the second diagnostic resistor R_D_2.

30
31 Two interruptions are drawn in the connection lines between
32 the first connections 3 of the first resistance elements R2
33 and R3 respectively, and also in the connection lines between

1 the second connections 4 of the two first resistance elements
2 R2 and R3. This indicates, as already indicated in the known
3 embodiment from Figure 2, that usually considerably more
4 first resistance elements are connected in parallel to the
5 three resistance elements R2, R3 shown. The breaks between
6 the first resistance elements R1, R2, R3 and between the
7 first measuring connection C1 and the second measuring
8 connection C2 also indicate that the power supply lines may
9 be very long in certain cases.

10
11 The circuit configuration shown in Figure 1 is used to
12 measure the resistance between the two measuring connections
13 C1 and C3, said resistance representing the total resistance
14 values of the additional resistance element R_SBR_1, the
15 diagnostic resistor R_D_1, the fixed resistor R_F_1 and the
16 power supply line resistances. The fixed resistor R_F_1 is
17 optional and as in Figure 2 its purpose is to define a
18 minimum measured value in the circuit configuration. The
19 diagnostic resistor R_D_1 is used to recognize line
20 interruptions and must be distinguished from a triggered
21 seatbelt warning resistance element S_SBR_1 by means of a
22 suitably different measurement range. Therefore in this case
23 its resistance value is between 2 and 200 k Ω . If the total
24 resistance of the parallel circuit containing the two
25 resistances R_SBR_1 and R_D_1 is reduced by a force pressing
26 on the resistance element R_SBR_1, this change is determined
27 by means of a change in the total measured resistance between
28 the two measuring connections C1 and C3.

29
30 The total resistance between the measuring connections C4 and
31 C2 is also measured in the same way as the total resistance
32 between the measuring connections C1 and C3. Comparing the
33 network between the measuring connections C1 and C3 with the

1 network between the measuring connections C2 and C4, the
2 resistors R_SBR_2, R_D_2 and R_F_2 are arranged in the same
3 way as the corresponding resistors R_SBR_1, R_D_1 and R_F_1.
4 The resistance in the second network is measured in the same
5 way as the resistance in the first network and therefore
6 requires no further explanation.

7
8 Compared with the circuit configuration in Figure 2, it is
9 possible to measure the first and second additional
10 resistance elements R_SBR_1 and R_SBR_2 in such a way that in
11 the ideal case the first resistance elements R1, R2 and R3
12 have no effect on the measurement. For this reason the two
13 resistance elements R_SBR_1 and R_SBR_2 can have the same
14 measurement range and therefore be manufactured in exactly
15 the same way as the first resistance elements R1, R2 and R3.
16 This means that a sensor seating mat for recognizing seat
17 occupancy having a circuit configuration according to Figure
18 1 can be manufactured considerably more cheaply than if it
19 had a circuit configuration according to Figure 2.

20
21 It is also possible to measure the first additional
22 resistance element R_SBR_1 and the second additional
23 resistance element R_SBR_2 independently of one another. The
24 advantage of this is that an unwanted shift in the measured
25 value of only one of the two additional resistance elements
26 R_SBR_1 or R_SBR_2 can be determined and a fault in the
27 circuit configuration can be recognized and subsequently
28 dealt with considerably more quickly and purposefully.

29
30 The circuit configuration in Figure 1 has the further
31 advantage that a break in the lines of the first network
32 between C1 and C3 on the one hand and of the second network
33 between C4 and C2 on the other can be elicited even without a

1 diagnostic resistance element R_D or diagnostic diode D_D:
2 measurement of the resistances in the first resistance
3 elements R1, R2 and R3 via the two measuring connections C1
4 and C2 is thus not affected by an additional resistance value
5 as in the circuit configuration according to Figure 2.

6
7 A diagnostic diode D_D is for example mainly used in a
8 circuit configuration according to Figure 2 in place of a
9 diagnostic resistor R_D when, with the aid of a resistance
10 measurement in the circuit configuration between the two
11 measuring connections C1 and C4, there is a need to
12 distinguish by means of the direction of the electric current
13 between a measurement with and a measurement without the
14 diagnostic component D_D. This kind of outlay on circuitry
15 and measurement is no longer necessary in the circuit
16 configuration according to Figure 1. Furthermore in the
17 circuit configuration in Figure 1, by reversing the direction
18 of the electric current when measuring the first resistance
19 elements R1, R2 and R3 a second measurement can be performed
20 as a plausibility test, and should give the same result as
21 the first measurement. This can act as a backup for the first
22 measurement.

23
24 A further advantage of having independently measurable first
25 resistance elements R1, R2, R3 and additional resistance
26 elements R_SBR_1 and R_SBR_2 is that the measurement ranges
27 of both resistance elements no longer need to be kept
28 separate from one another in order to be able to distinguish
29 from the measurement result whether at least one of the first
30 resistance elements R1, R2, R3 has been depressed or in
31 appropriate cases whether one of the two additional
32 resistance elements R_SBR_1 or R_SBR_2 has also been
33 depressed. The measurement range for the first resistance

elements R1, R2, R3 can therefore be extended.

Figure 4 shows a preferred resistance element R1 for recognizing seat occupancy, being exemplary of all the resistance elements R1, R2, R3, with conductors 3 and 4 between two-way connections 31 and 32, 41 and 42 respectively, being fed to the first measuring connection C1 and the third measuring connection C3, and the fourth measuring connection C4 and the second measuring connection C2, respectively.

In the diagram shown, the first conductor 3 forms a first arc curving upward toward the upper lateral face and the lower conductor 4 forms a second arc curving correspondingly down toward the lower end. The first conductor 3 is arranged on a first backing film PPD1 and the second conductor 4 is arranged on a second backing film PPD2. This will be fully explained below with the aid of the cross-section view of the resistance element R1 in Figure 5.

The obliquely shaded surface 3' enclosed by the two arcs represents a semi-/conducting layer 3' arranged below the first conductor 3, and the vertically shaded surface 4' represents a semi-/conducting layer 4' arranged above the second conductor 4, so that the two semi-/conducting layers 3' and 4' face toward one another. The semi-/conducting layers 3' and 4' may be for example graphite layers 3' and 4'.

Unlike the diagram in Figure 4, in a real embodiment of a first resistance element R1 the first and second conductors 3 and 4 completely fill the circular surfaces associated with the respective arcs shown, but it would be difficult to

1 illustrate this clearly.

2
3 Figure 5 shows the resistance element R1 from Figure 4 as a
4 cross-section through the sensor seating mat PPD. The first
5 conductor 3 is arranged on the first backing film PPD1 and
6 the second conductor 4 is arranged on the second backing film
7 PPD2. The backing films PPD1 and PPD2 are kept apart from one
8 another by spacers 9. There is a hollow space between the
9 graphite layers 3' and 4' instead of a spacer 9.

10
11 Two-way pressure on the resistance element R1 in the
12 direction of the hollow space deforms the resistance element
13 R1 and the hollow space becomes smaller until the graphite
14 layers 3', 4' fastened on the first conductor 3 and those on
15 the second conductor 4 come into contact. As the pressure
16 increases, the resistance value of the resistance element R1
17 between the drawn connections 31 and 34 of the first and
18 second conductors 3, 4 respectively decreases further and
19 further.

20
21 A power supply line on the first backing film PPD1 is fed
22 from the connection 31 to the first measuring connection C1,
23 and a further line is fed from the connection 42 along the
24 second backing film PPD2 to the second measuring connection
25 C2: the resistance element R1 is a resistance element in
26 through mode technology.

27
28 Figures 6 and 7 show a resistance element R_SBR1 for seatbelt
29 warning.

30
31 Figure 6 shows a top view of the resistance element R_SBR1.
32 The resistance element R_SBR_1 is in shunt mode technology.

33

1 Unlike the resistance element R1 from Figure 4, the two
2 conductors 3 and 4 are arranged opposite one another in the
3 form of semicircles under the first backing film PPD1. To
4 simplify illustration of the obliquely shaded graphite layers
5 3' and 4' lying directly under the conductors 3 and 4
6 respectively, the semicircles are not shown to cover them
7 fully as would usually be the case for a real embodiment of
8 such a resistance element R_SBR1.

9
10 The vertically shaded surface in Figure 6 is the graphite
11 layer 5' on the conductor 5 opposite the two graphite layers
12 3' and 4', and is arranged on the second backing film PPD2.

13
14 As in the case of the first resistance element R1 in Figures
15 4 and 5, the two backing films PPD1 and PPD2 are kept apart
16 from one another by spacers 9, as a result of which the
17 graphite layers 3' and 4' of the first backing film PPD1 are
18 separated by a hollow space from the graphite layer 5' on the
19 second backing film. If the graphite layers 3', 4' are
20 pressed onto the opposite graphite layer 5', current can flow
21 between the measuring connections C1 and C3, which are
22 connected to the two conductors 3, 4.

23
24 The details described in Figures 6 and 7 with reference to
25 the first resistance element S_BR1 also apply in equal
26 measure to the second resistance element S_BR2, in which case
27 the measuring connections C2 and C4 shown in parentheses take
28 the place of the measuring connections described previously.

29

30

31

32

33